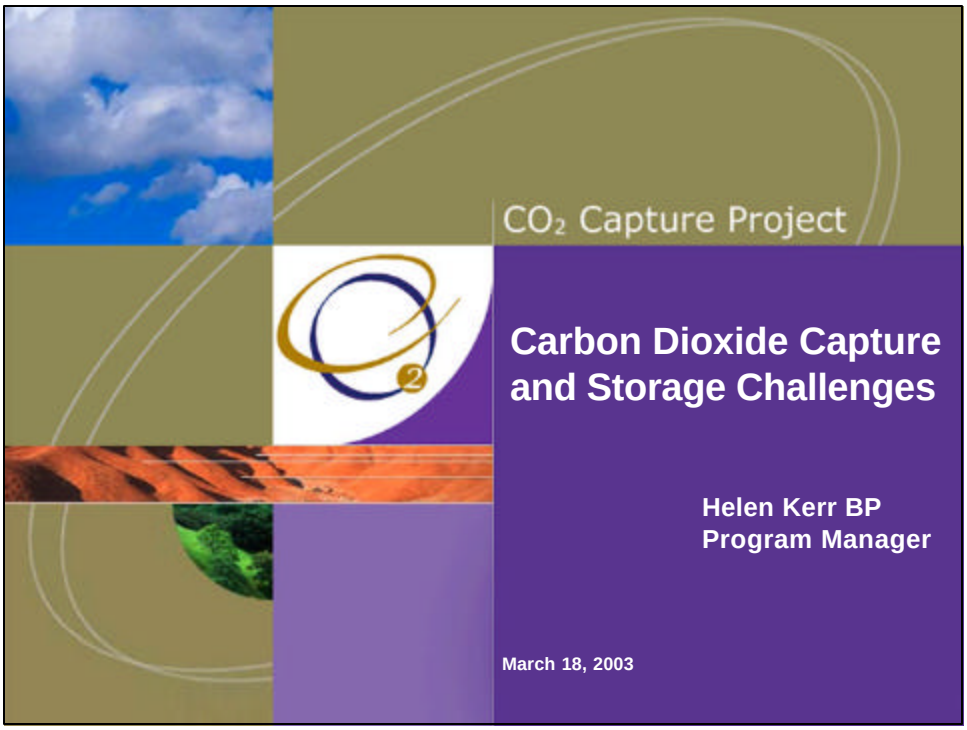
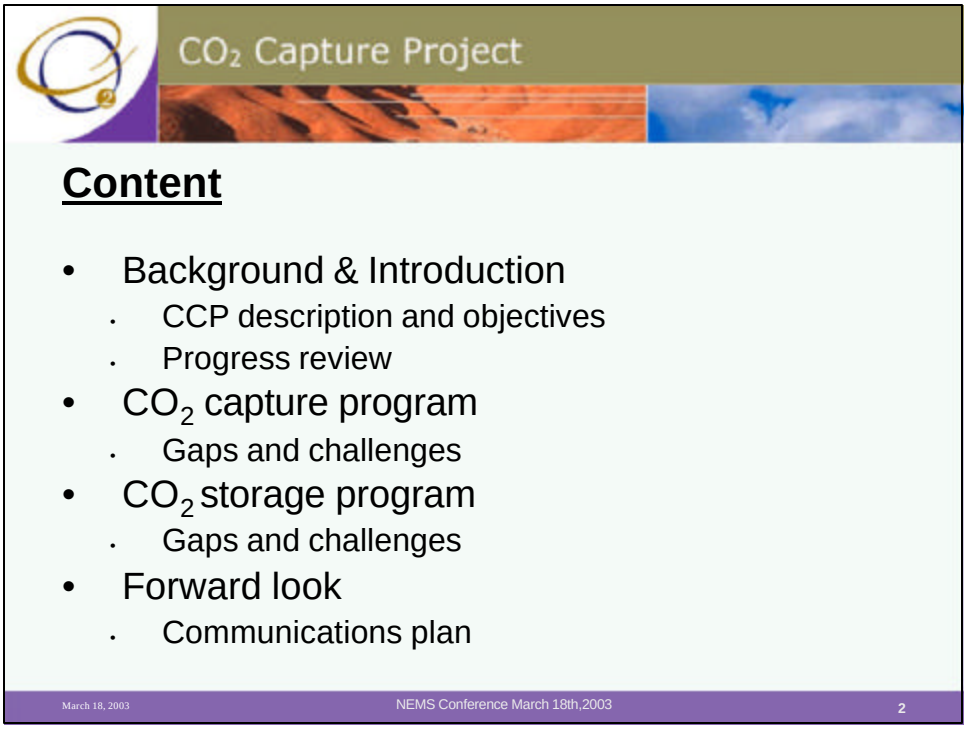

CO2 Capture Project
Carbon Dioxide Capture and Storage Challenges
Helen Kerr BP
Program Manager
March 18, 2003


CO2 Capture Project
Content
Background & Introduction
CCP description and objectives
Progress review
CO2 capture program
Gaps and challenges
CO2 storage program
Gaps and challenges
Forward look
Communications plan
March 18, 2003
NEMS Conference March 18th,2003
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CO_2 Capture Project
bp
ChevronTexaco
EnCana
Eni
HYDRO
STATOIL
SUNCOR
US Department of Energy
European Union
Klimatek NorCap
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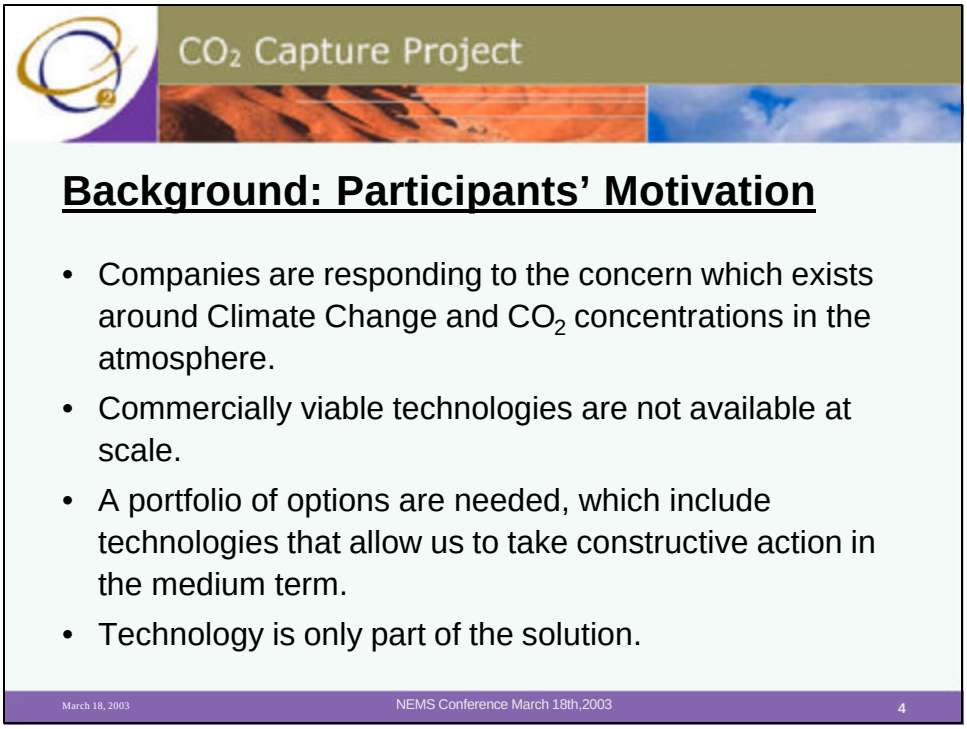
CO_2 Capture Project
Background: Participants' Motivation
• Companies are responding to the concern which exists around Climate Change and CO_2 concentrations in the atmosphere.
• Commercially viable technologies are not available at scale.
• A portfolio of options are needed, which include technologies that allow us to take constructive action in the medium term.
• Technology is only part of the solution.
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Background: Why Focus on Capture and Geologic Storage?

- Opportunity to add value through beneficial use of CO_2
- Possibility to achieve very material reductions in CO_2 emissions
- Energy companies often control both source and sink
- Many years of experience successfully managing geologic reservoirs and storage of fluids/gas
  - Early opportunity to learn by utilising high purity, concentrated streams of CO_2 already available and store it in oil and gas reservoirs

CO_2 Capture Project Objectives

- Achieve major reductions in the cost of CO_2 Capture and Storage:
  - 50% reduction when applied to a retrofit application.
  - 75% reduction when applied to a new build application.
- Demonstrate to external stakeholders that CO_2 storage is safe, measurable, and verifiable.
- Progress technologies to:
  - 'Proof of concept' stage by 2003/4.

CO_2 Capture Project

What will be delivered

- Over 50 internationally peer reviewed key studies on capture and storage
- Capture technologies for real scenarios demonstrating possible cost reductions
- Guidelines on HSE risk assessment, monitoring and verification for geologic storage
- Final reports, papers, produced in a variety of media
- Conclude outreach activities

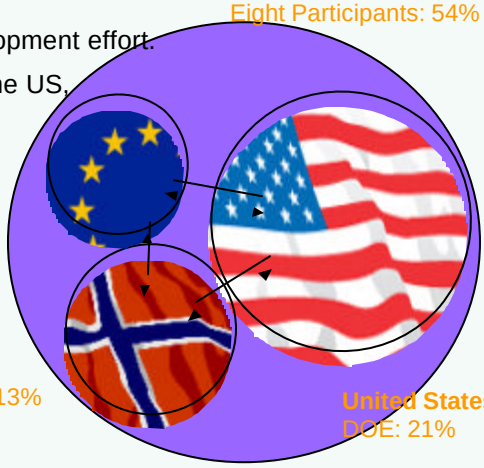
CO_2 Capture Project

Program Structure

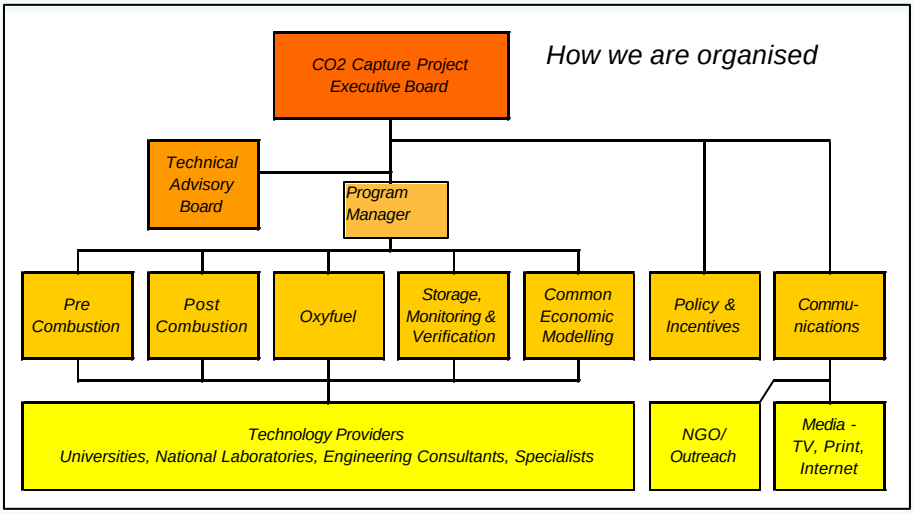
- International technology development effort.
- Distinct *regional* programs in the US, Norway, and European Union.
- Sharing among programs to leverage results and reduce duplication.
- Project Funding

Cash $25mm +

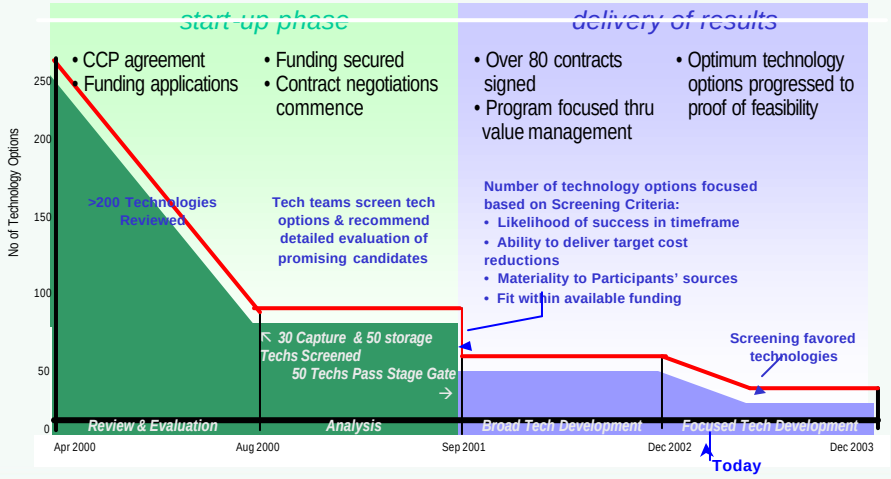
ca. $25mm In–kind



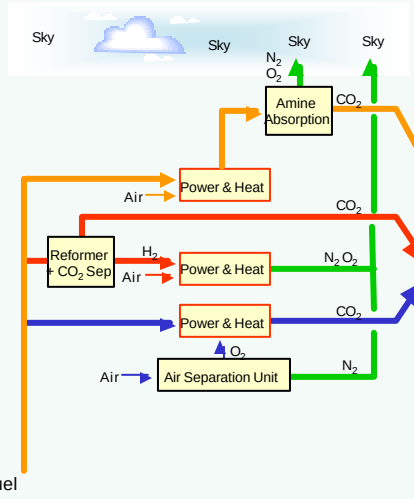
How we are organised



Project Overview- We've come a long way!



CO_2 Capture & Storage Options



Storage options

- Enhanced Oil Recovery
- Enhanced Coal Bed Methane
- Old Oil/Gas Fields
- Saline Formations

CO_2 Capture Project

Critical Gaps Identified

Gaps: Post Combustion

- Cost
- Temperature & amine performance
- Alternative absorption processes
- Size of equipment
  - Absorber technology
  - Membrane materials
- Energy requirements
  - Waste heat recovery (WHR)
  - Compression
  - Amine conditioning/recovery

Gaps: Pre Combustion

- Cost
- Hydrogen manufacture processes
  - New processes to reduce cost and improve efficiency at scale
  - Integrating Syngas production with CO_2 capture
- Size of equipment
  - Can we scale up what works on small scale?
- Energy requirements
  - WHR
  - Compression

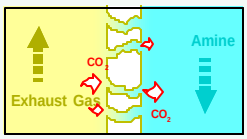
Gaps: Oxyfuel

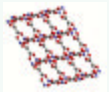
- Cost
- Temperature of process
- Process efficiency
  - Integration with pre-and post combustion processes for CO_2 Capture
- Energy requirements

Capture: Summary of Progress

Post Combustion studies

Process Integration and standards review underway
Advanced membrane separation & solvent pilot scale study complete
Specific, nanoporous , stable solid adsorbents under Development
other novel chemistries and approaches investigated

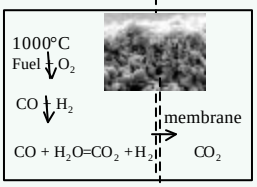




Example of solid adsorbant

Pre-Combustion studies

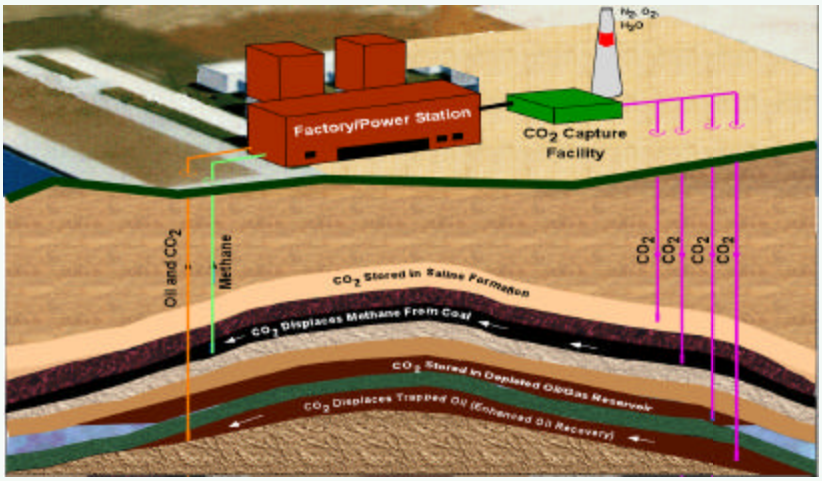
Scale up e.g VLS autothermal reforming
Gas Turbine retrofit, Heaters & boilers conversion
Compact reformer development
Step reduction & integration; H_2 membrane reactor



Oxyfuel studies in progress

Chemical looping , i.e. O_2 generation in -situ
Heaters and boilers conversion studies

Storage Technology – Geologic options



Storage: key findings on state-of–the-art (SOA) review

- The industry has many of the competencies and answers we need
  - Decades of experience in sequestering CO_2 in EOR fields
  - Industry has experience in naturally occurring CO_2 producing fields (analogs) in the US
  - In the US and Europe, the natural gas industry has 90 years of experience storing natural gas in 100s of fields
- CCP should not duplicate significant, third-party research & development worldwide
  - Understanding geologic storage, maximizing storage efficiency, short-term verification & monitoring are understood or are receiving significant third-party R&D

Gaps: Storage Monitoring and Verification

- Cost
- HSE Risk Assessment Methodology
  - Leakage
  - Contamination
  - Mitigation
- Long term monitoring standards and tools
- Verification

Storage: Summary of Progress

HSE Risk Assessment & Methodology

HSE risk assessment SOA*

HSE risk assessment & methodology guidelines

Learning from acid gas storage

Learning from natural analogs

Legal aspects of CO_2 storage *

Learning from long term EOR and gas storage

Probabilistic study on CBM storage

& Others…..

Long Term Monitoring

Spectral analysis of plant stress from aerial images

CO_2 impact on well tubulars & cement

Optimum monitoring methods

Noble gas labeling to detect CO_2 leak source

Pipeline transportation costs material selection

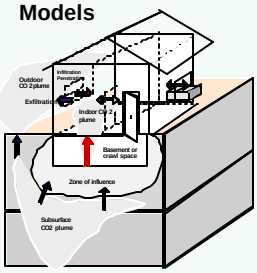
CO_2 detection techniques*

Geological studies

Modeling CO_2 movement

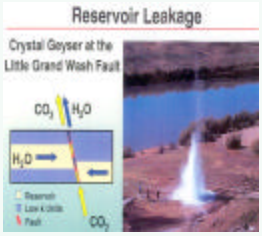
Effects of injection on properties of reservoirs and cap-rock

Models

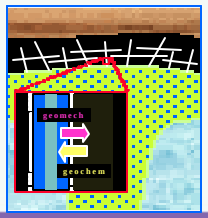


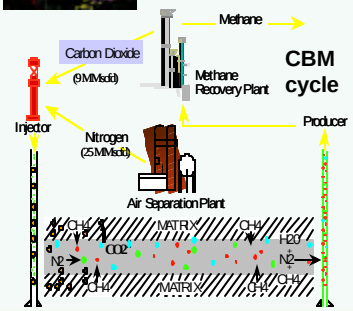
Leak detection

Natural analogs

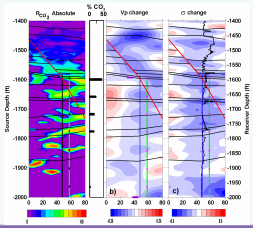


Caprock mechanics





Reservoir movement



Models!!!! Understanding geologic storage requires the development and integration of many models and results

Compartment	Mechanical processes	Hydraulic processes	Physico-chemical processes	Marine hydraulic processes	Atmospheric physical processes
Storage reservoir	DIANA	SIMED DIANA	TAFFETAS/ MARTHE		
Seal					
Overburden					
Shallow aquifer/soil			STOMP		
Hydrosphere (sea)				DELFT3D	
Atmosphere					PLUME+/ LOTOSUAM

Next Steps: Demonstration Needs

- Necessary to prove technology, reduce business risk demonstrate track record
- Separation and Capture
  - Detailed process engineering and design of concept and technology
  - Large scale field demonstration of technology
- Geologic Storage
  - Large scale field demonstrations
  - Various types of formations
  - Demonstrate tool performance and reliability

Next Steps: SMV Communications

- We don't want to have 40 studies "sitting on the shelf"
- Rather, we want integrated series of reports that demonstrate that
  - CO_2 storage can be safe and effective
  - CO_2 can be monitored both short and long-term
  - CO_2 storage is verifiable
- Have engaged professional communications consultants to help us.

Next Steps: General Communications

- We plan to engage a professional association and journal
  - Extensive peer-review world-wide
- Current vision is for 3-4 key audiences e.g.
  - Scientific Journal, highly technical (200 - 500 pages)
  - Government Report and Road Show (10 -100 pages)
  - Public reader-friendly version (3 -10 pages)
  - TV documentaries for BBC, Nova, Discovery Channel
- Consultant's work proposals in hand
- Deployed by 1Q 2004

Watch this space!

Or visit CO2captureproject.org